



SCENARIO DESIGN FOR THE EMPIRICAL TESTING OF ORGANIZATIONAL CONGRUENCE

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OBJECTIVES



- ESTABLISH EXPERIMENTAL CONDITIONS WITHIN WHICH TO DEMONSTRATE THAT CONGRUENCE SIGNIFICANTLY AFFECTS PERFORMANCE OUTCOMES
- **HYPOTHESIS** ~ “*the better an organization is matched to the overall mission, using a multi-variant set of workload and other congruence metrics, the better will that organization perform*”

Congruence \Rightarrow the **interaction** of organizational structure **and** mission/scenario
(degree of structural **fit** between an organization and the mission)

- UNDER A2C2, A METHODOLOGY HAS BEEN DEVELOPED TO DESIGN AN ORGANIZATION THAT IS **CONGRUENT** WITH A **SPECIFIED** MISSION
 - who should own what assets, who does what, who sees what, etc.
 - extensive publications in past CCRTS Proceedings, SMC Transactions, ...
 - limited empirical testing conducted in previous A2C2 experiments
(usually via comparison with an ad-hoc organizational structure on one scenario)

APPROACH



- EXPLOIT FINDINGS FROM TWO PREVIOUS EXPERIMENTS CONDUCTED AT NPS
 - N6C (March 2001), C8 (October 2001)

STEP 1: SEEK TWO VERY DIFFERENT ORGANIZATIONAL STRUCTURES

- Functional (**F**) and Divisional (**D**)

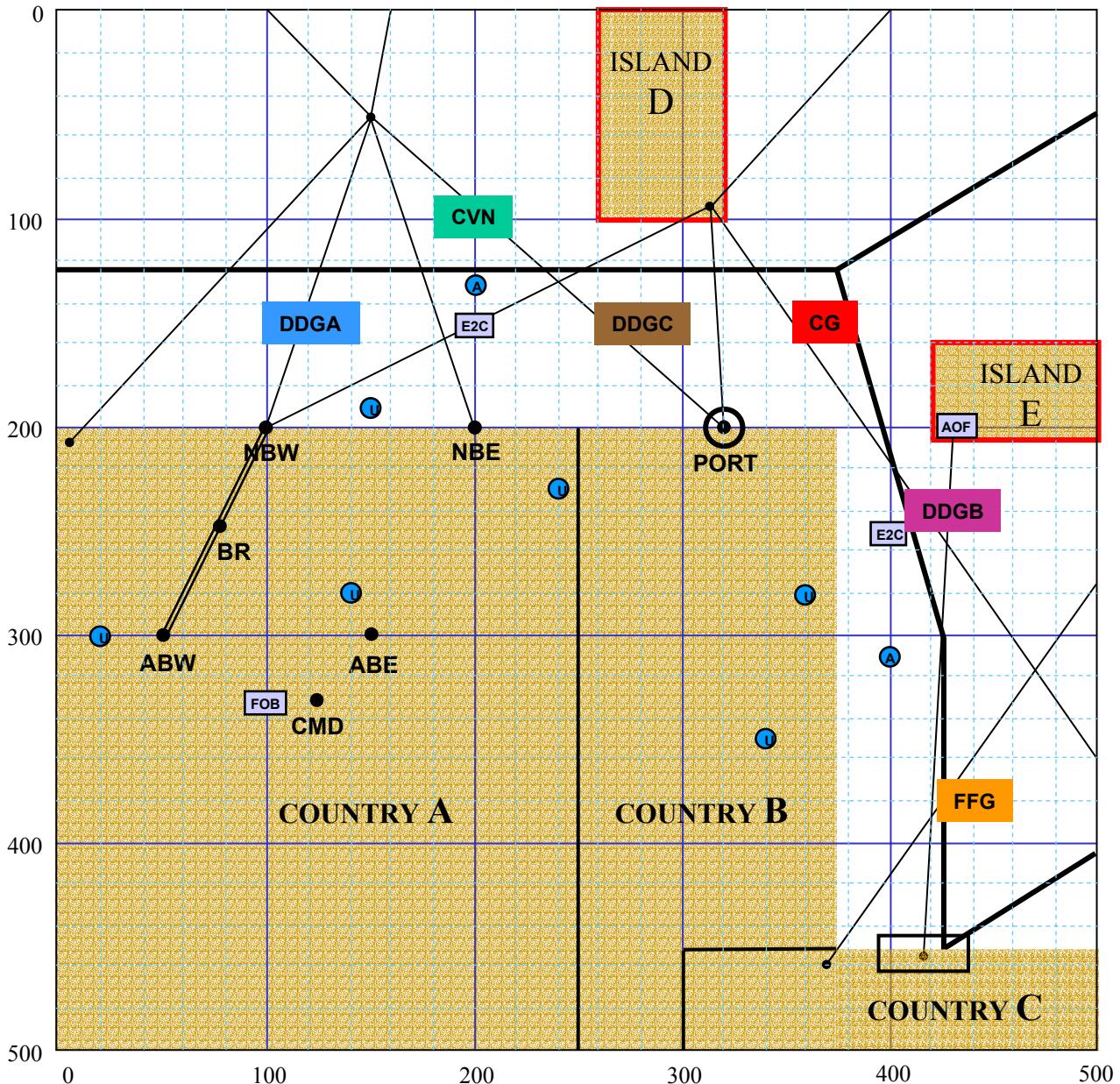
then

STEP 2: DESIGN TWO SCENARIOS TO EXPLOIT THE DIFFERENCES IN **F** AND **D**

- **f** congruent with **F** but measurably incongruent with **D**
- **d** congruent with **D** but measurably incongruent with **F**

- UTILIZE THE SAME MILITARY CONTEXT AS IN PREVIOUS EXPTS FOR **f** and **d**
 - DDD simulator reuse, ease of subject training, etc.
- USE CONGRUENCE THEORIES TO “REVERSE ENGINEER” **f** and **d**

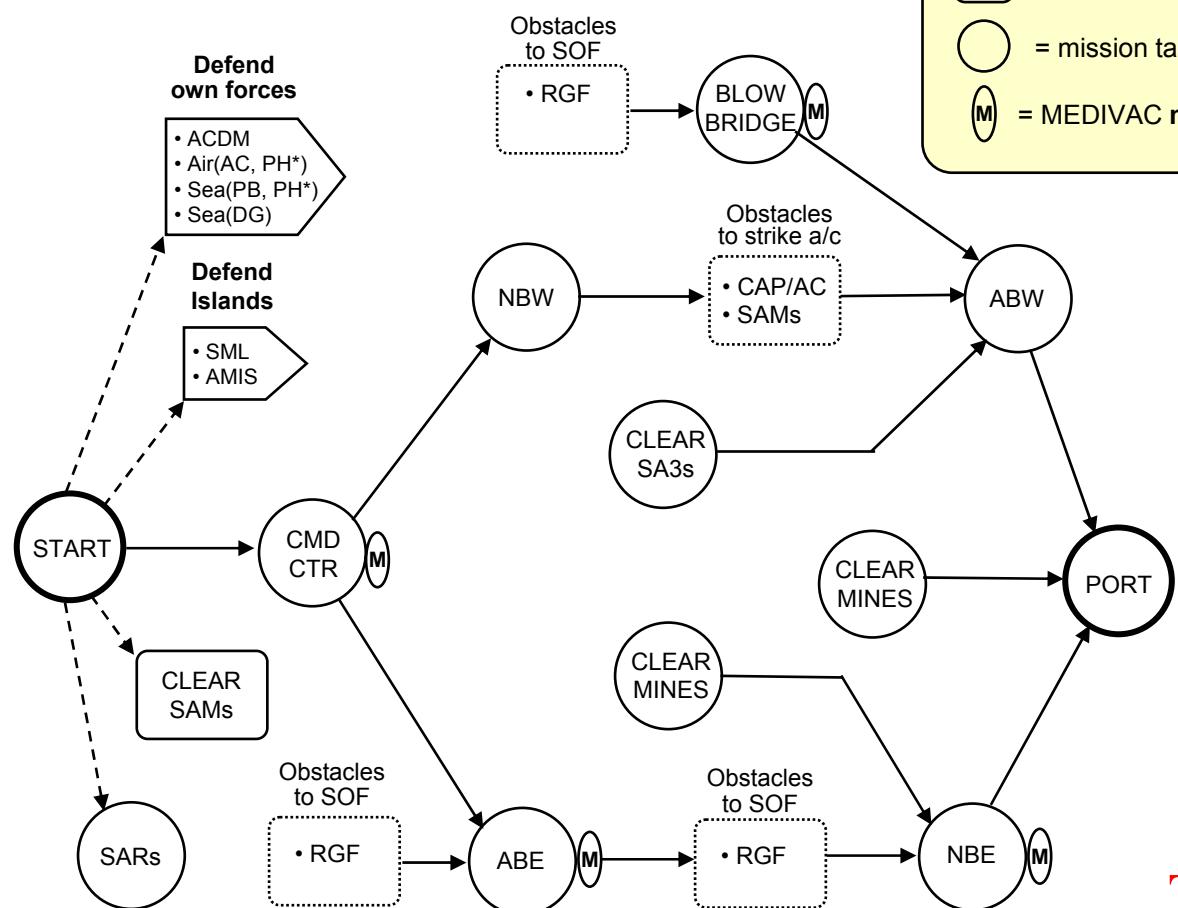
EXPERIMENT 8 SCENARIO AOR



- Country A has invaded B
 - remove A's forces from B
- Prepare for introduction of follow-on forces
 - Clear SAMs North of 325
 - Clear mines: NBE, PORT
 - Dominate air and sea
- Respond rapidly to high-priority unanticipated tasks and (combat) S&R
- Protect D and E from A's SCUD missile attacks
- Defend Task Force assets
 - vs. enemy air and sea

A course of action (COA) giving a specific sequence for accomplishing mission tasks has been developed by the CJTF.

FUNDAMENTAL TASK GRAPH A2C2 EXPT 8



- ◇ = aggregated defend task, showing **possible** subtasks
- = aggregated encounters task, with **possible** subtasks
- = mission tasks (that must be done); known in advance
- M = MEDIVAC **may** spawn as a result of performing task

- **PREREQUISITE** requirements exist among key mission tasks (establishes mission ordering)
- **OBSTACLES** to own forces that inhibit access to mission tasks may be encountered (need clear enemy defenses)
- **ENEMY THREATS** to friendly nations *and* your own forces

THE MISSION IS THE HIGHEST PRIORITY!!

* indicates that these must be distinguished from neutral (or decoy) counterparts

TWO ORGANIZATIONAL STRUCTURES: D and F



TEAMS OF SIX PLAYERS EACH: FLAT HIERARCHY, EMPOWERED

- **FUNCTIONAL:** A DM is a warfare area commander and “owns” all appropriate JTF assets
 - a single warfare area that is theater-wide
- **DIVISIONAL:** A DM “owns” a single multi-function capable platform with all its subplatforms
 - multiple warfare areas in a defined geographical region

Functional

DM		1	2	3	4	5	6
	Platform	STRIKE	BMD	ISR	AWC	SuWC/MINES	SOF/SAR
1	CVN	2F18S	xxx	1UAV	2F18A, E2C	1FAB, 1MH53	1HH60
2	DDGA	8TLAM	3ABM,4TTOM	1UAV	6SM2	1FAB, 2HARP	1HH60,1SOF
3	DDGB	8TLAM	3ABM,4TTOM	1UAV	6SM2	1FAB, 2HARP	1HH60,1SOF
4	CG	8TLAM	3ABM	1UAV	6SM2	1FAB,2HARP,1MH53	1HH60
5	FFG*	2F18S	xxx	1UAV	2F18A,E2C,4SM2	1FAB,2HARP,1MH53	1HH60
6	DDGC	8TLAM	3ABM,4TTOM	1UAV	6SM2	1FAB, 2HARP	1HH60,1SOF

* FFGs fixed wing aircraft are located on an island Air Operation Facility (AOF)
 SOFs are pre-inserted and located on a Forward Operating Base (FOB)



CONGRUENCE MANIPULATION EXPLOITS ROLES and GEOGRAPHY,
PLUS TASK REQUIREMENTS, ASSET CAPABILITIES and LOCATIONS

→ **1) INCREASE DM-DM COORDINATION**

- Introduce tasks that require multi-DM processing
- Construct many of these tasks to be time-critical and/or unanticipated, with a finite time window within which assets must synchronize
- Introduce precedence/prerequisite and information-dependence (flow) structure among tasks allocated to different DMs ⇒ create dependence of one DM’s processing upon another DM’s success/activities
 - (e.g., ISR for detection, obstacles to assets, mission task graph, ...)

→ **2) CREATE WORKLOAD (TASK LOAD) IMBALANCE AMONG DMs**

- Introduce temporal overload of tasks that must be done by one DM

3) OTHER MANIPULATIONS

- Create a set of tasks where inefficient asset utilization is “costly”
(Provide team with limited assets that must be used efficiently)
- Reduce situational awareness within team and among DMs
(Create tasks that cause DMs to adopt “tunnel vision”)
- Insert tasks that “boundary-split” regions between adjacent DMs

MECHANICS OF SCENARIO DESIGN (1 and 2)

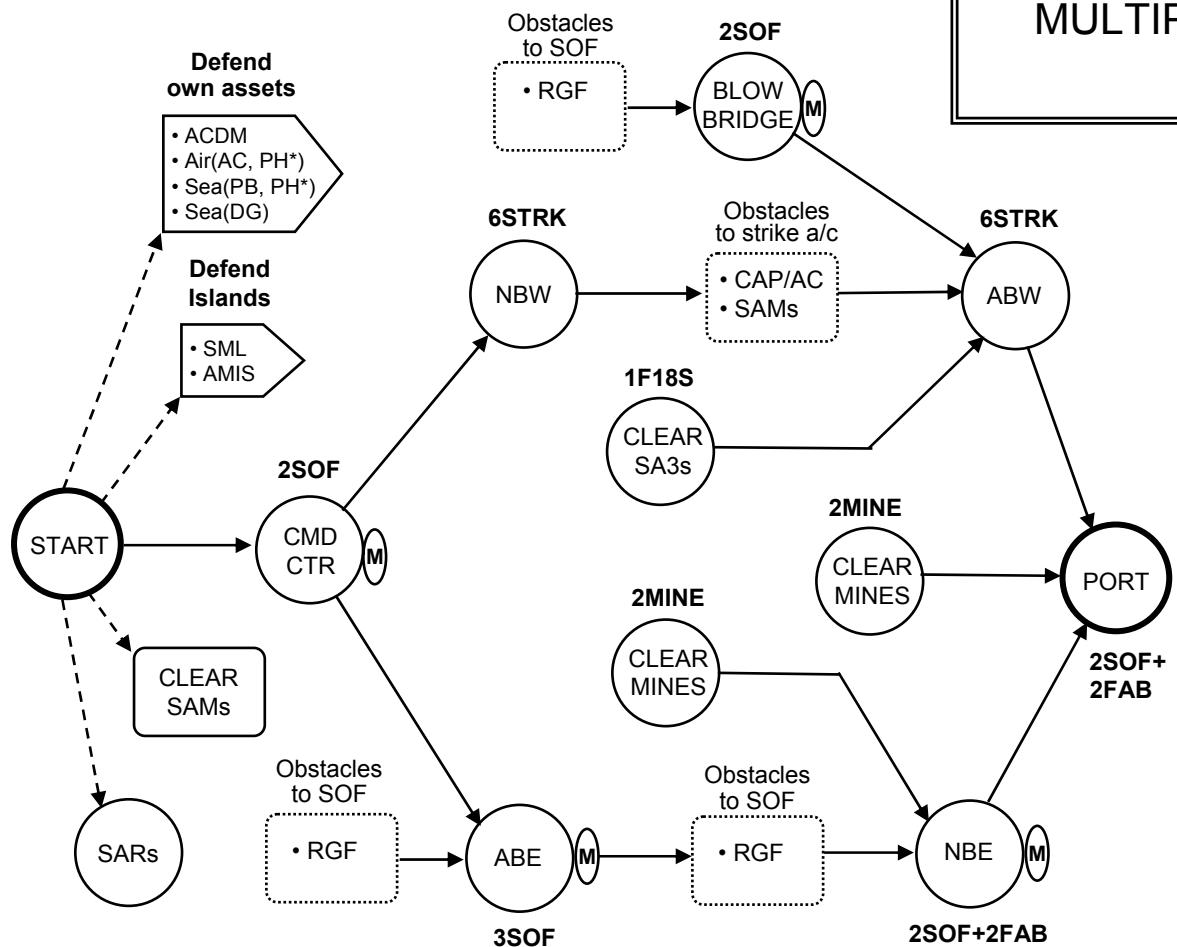


SCENARIO f: (congruent with organization **F**; incongruent with organization **D**)

1. INTRODUCE TASKS WITH HIGH RESOURCE REQUIREMENTS OF THE **SAME** TYPE (REQUIRE DIVISIONAL DMS TO COORDINATE)
 - e.g., task requiring multiple units of STRIKE
2. CREATE TEMPORAL OVERLOADS USING TASKS OF **DIFFERENT** TYPES **IN ONE GEOGRAPHICAL AREA** (e.g., simultaneous *air* + *sea* + S&R tasks)
 - increase the workload of a selected **divisional** DM

SCENARIO d: (congruent with organization **D**; incongruent with organization **F**)

1. INTRODUCE TASKS WITH RESOURCE REQUIREMENTS OF **DIFFERENT** TYPES (REQUIRE FUNCTIONAL DMS TO COORDINATE)
 - e.g., task requiring 1 unit each of SOF, STRIKE and AIR
2. CREATE TEMPORAL OVERLOADS USING TASKS THAT NEED **ONE** RESOURCE TYPE SPREAD OVER A **LARGE GEOGRAPHICAL AREA**
 - e.g., an enemy *air* wave simultaneously targeting several platforms
 - increase the workload of a selected **functional** DM



MAJOR TASKS REQUIRE
MULTIPLE RESOURCES OF
SAME TYPE

TASK RESOURCE REQMTS

SDG: 2 ASuW

SPT, SPH: 1 ASuW

SGUN: 2 FAB

SSAR: 2 SAR

SMIN: 2 MINES

GEVA: 2 SAR

GCDL, GSML: 1 STRK

GSAM: 2 TLAM (from 2 different platforms)

GSA3: 2 STRK (1 F18S)

GSA6: 2 TLAM (from 2 different platforms)

GRGF: 3 STRK

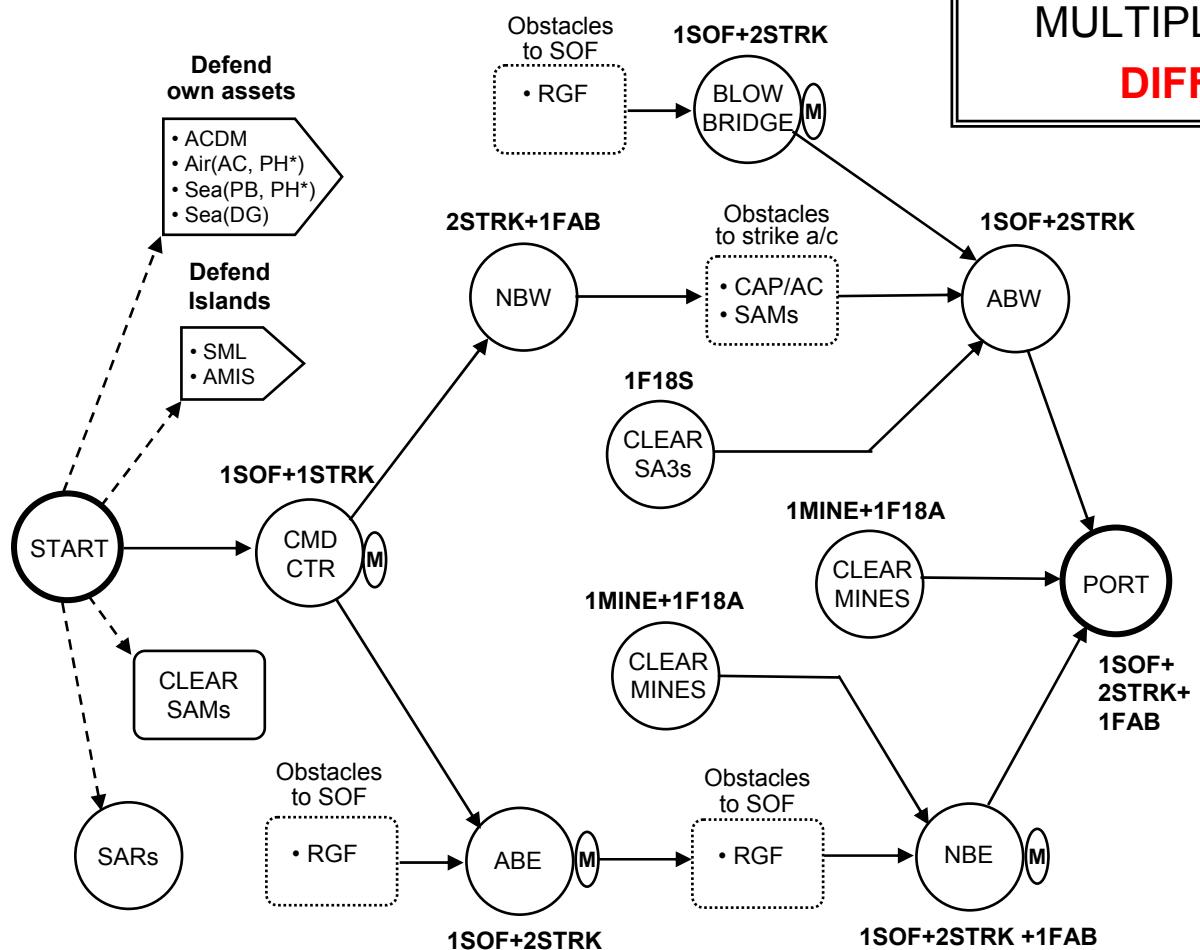
AAC, APH, ACDM, AXOC: 1 AAW

ACAP: 3 AAW

AMIS: 1 ABM

- other unanticipated tasks via HELP

* indicates that these must be distinguished from neutral (or decoy) counterparts



MAJOR TASKS REQUIRE
MULTIPLE RESOURCES OF
DIFFERENT TYPES

TASK RESOURCE REQMTS

SDG: 1 ASuW + 1 AAW

SPT, SPH: 1 ASuW

SHOS: 1 SAR + 1 FAB

SSAR: 1 SAR + 1 FAB

SMIN: 1 MINES + 1 F18A

GEVA: 1 SAR + 1 F18A

GCDL, GSML: 1 STRK

GSAM: 1 TLAM + 1 SOF

GSA3: 2 STRK (1 F18S)

GSA6: 2 TLAM (from 2 different platforms)

GRGF: 2 STRK

AAC, APH, ACDM, AXOC: 1 AAW

ACAP: 2 AAW

AMIS: 1 ABM

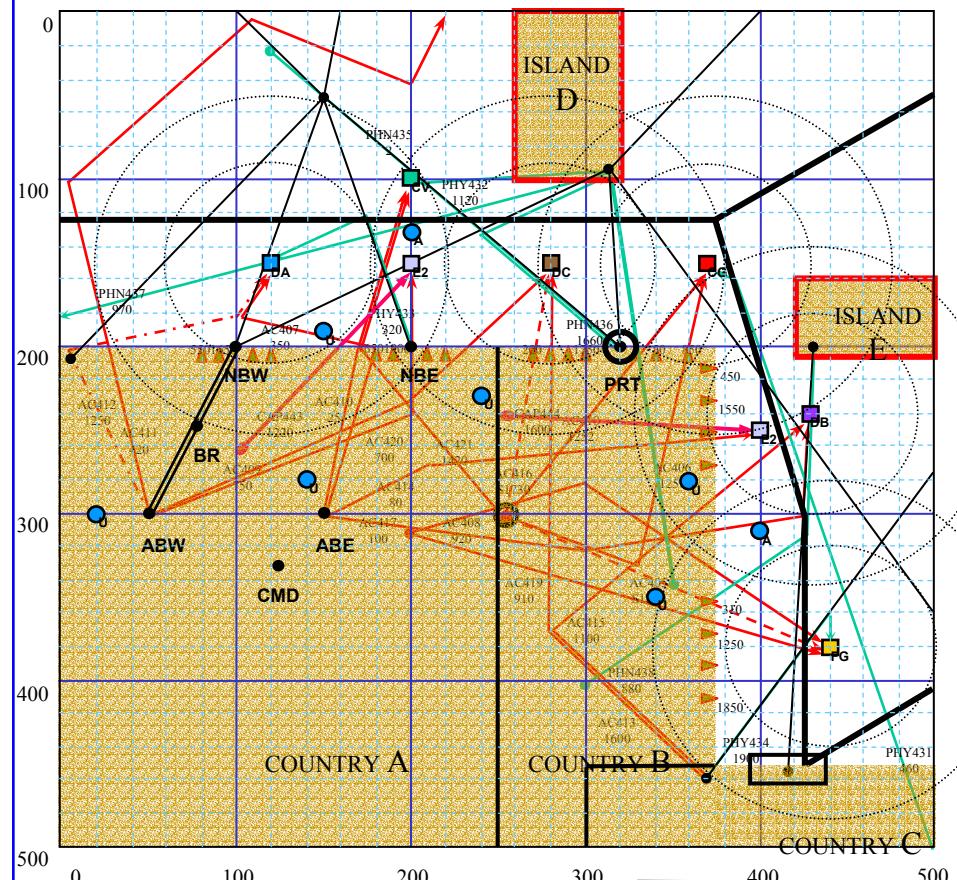
- other/unanticipated tasks via HELP

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TASK SPATIAL AND TEMPORAL DESIGN



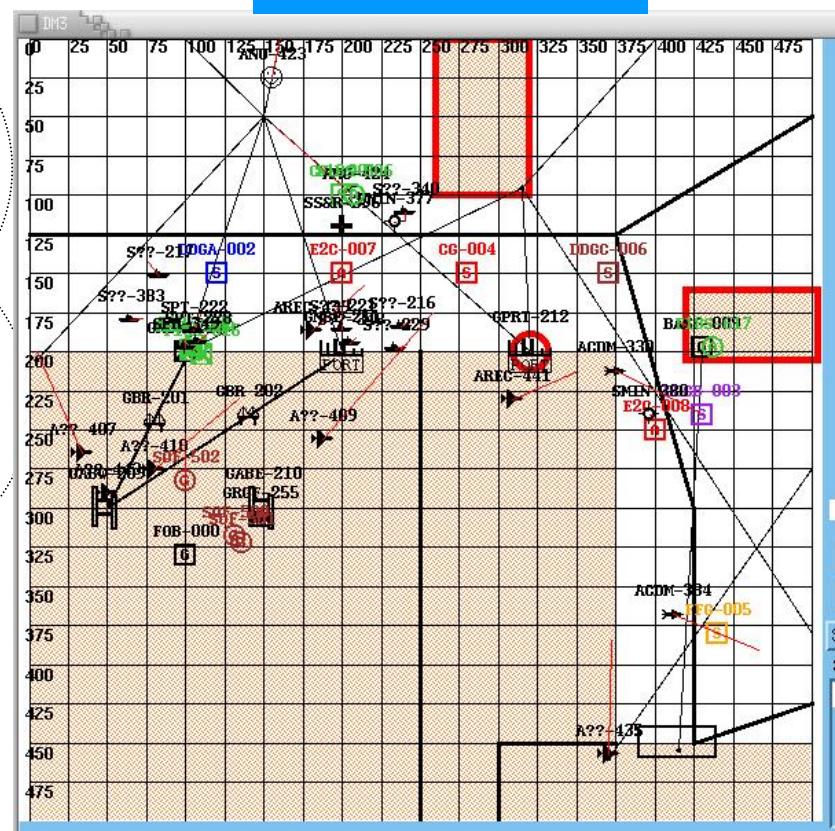
Ex: Scenario f, air tasks design



IMPLEMENTATION

Task types, arrival times, & paths are adjusted to meet design requirements
- each DM experiences 2-3 periods of overload within a given scenario

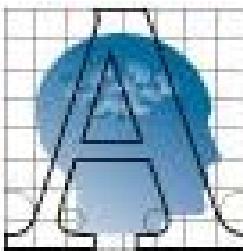
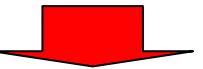
DDD Simulator



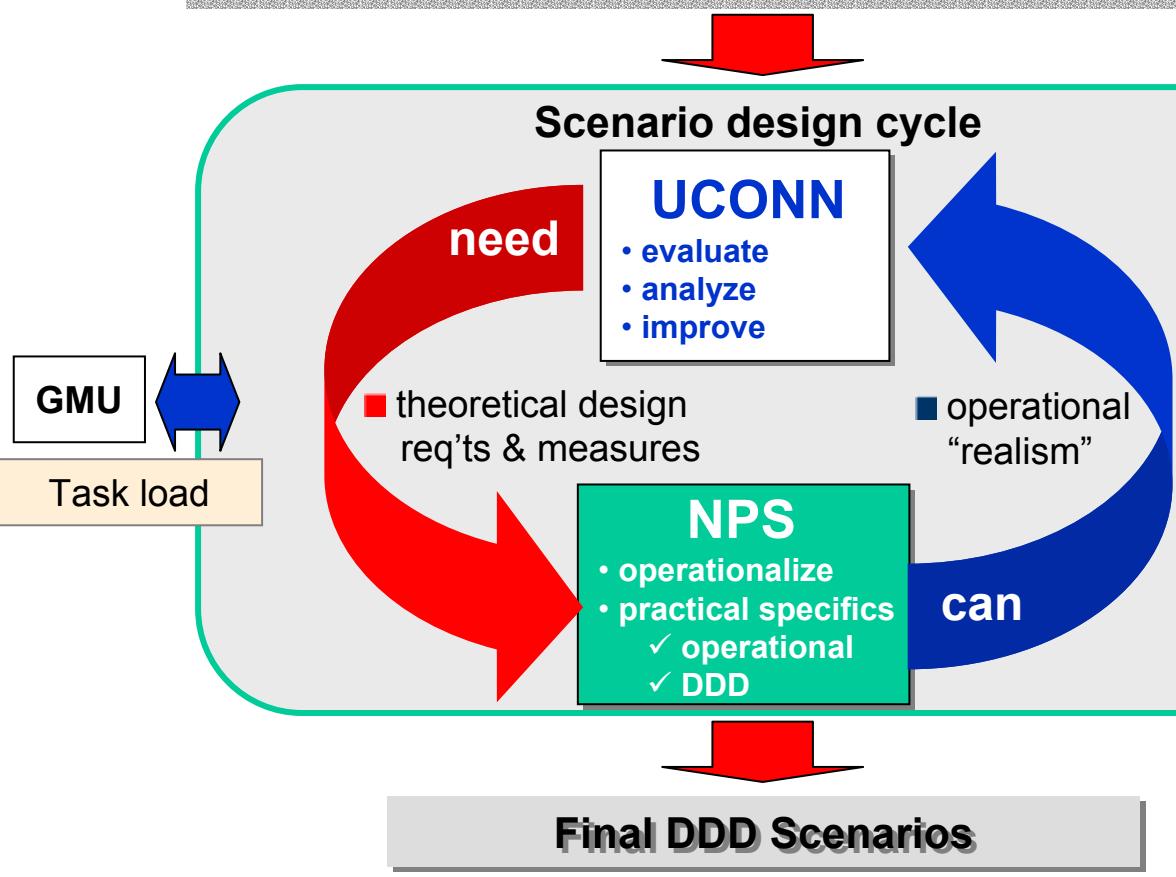
MODELING CYCLE FOR EXPERIMENT 8



N6 & C8 scenarios and structures



Create two distinct structures – **Divisional** and **Functional**



1. Organizations

- **F**: Minimize overlap of resource capabilities
- **D**: Maximize overlap of resource capabilities

2. Scenario - Coordination

- **f**: tasks requiring multiple resources of **same type**
- **d**: tasks requiring multiple resources of **different types**

3. Scenario - Task load

- **f**: load **single geographical area** over multiple functions and time
- **d**: load **single functional area** over a wide geographical region and time



EXPERIMENT 8 WAS CONDUCTED IN AUGUST AND NOVEMBER 2002

- **PLAYER RATINGS*** OF FACTORS THAT AFFECTED PERFORMANCE

	D Teams		F Teams	
“What made playing these scenarios difficult for you?”	d	f	f	d
Need for Coordination	4.3	5.5	3.7	5.4
Task Load	4.1	4.6	3.7	4.4
Secondary Task Demands	4.6	4.5	3.0	3.5
“How proactive vs. reactive did you feel you were when playing each scenario?”	5.1	3.6	4.7	4.2

* Note: Ratings used a 7-point scale

- IN WHICH SCENARIO DID YOU FEEL THAT YOUR TEAM PERFORMED “BETTER”?
 - 96% of Divisional participants reported “better” in congruent (d) scenario
 - Only 52% of Functional participants reported “better” in congruent (f) scenario

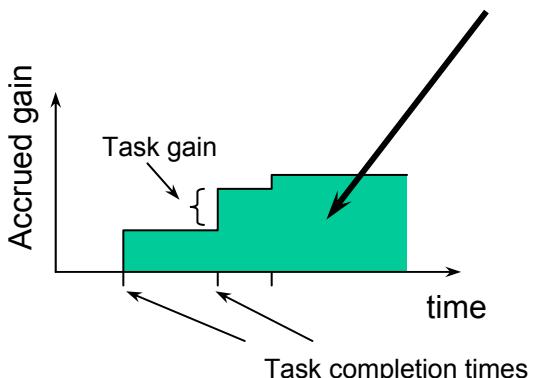
SUMMARY & CONCLUSION



- MODEL-BASED EXPERIMENTAL AND SCENARIO DESIGN
 - Integrated scenarios, organizational structures, and congruence metrics
 - “Reverse engineered” f and d using congruence theories
- SO, DO CONGRUENT ORGANIZATIONS **PERFORM BETTER?**
 - Model-based performance and process measures of congruence effects exist
 - Can associate nature of incongruence with asymmetric performance decrements e.g., $F \Leftrightarrow d$ and $D \Leftrightarrow f$.
- **YES!** – EXTENSIVE RESULTS ARE FOUND IN COMPANION PAPERS

Example: Accrued Task Gain metric (gain = value*processing accuracy)

AREA UNDER CURVE IS A MEASURE OF **OVERALL PERFORMANCE**



	d	f
D	45.8	33.6
F	33.5	42.8

On average the CONGRUENT teams significantly outperformed the NON-congruent teams
- better time-accuracy tradeoff
- but . . .